Part

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Section 2: Biological Profile of List A and B Fish Species

Biological Profile of List A and B Fish Species

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TABLES AND FIGURES

INTRODUCTION

Fish species residing on PL lands display both resident and anadromous life history strategies. Most anadromous species spend the majority of their lives at sea, entering fresh water to reproduce, while resident species spend their entire life in freshwater. Anadromous fish species on the ownership include: chinook salmon, coho salmon, steelhead trout, sea-run cutthroat trout, and Pacific lamprey (Table 1). Resident fish species include: coastal cutthroat trout, rainbow trout, California roach, Sacramento sucker, Sacramento squawfish, threespine stickleback, prickly sculpin, and coastrange sculpin (Table 1). Although not expected to occur on PL's lands, eulachon *(Thaleichthy pacificus)*, green sturgeon *(Acipenser medirostris)*, longfin smelt *(Spirinchus thaleichthys)*, and tidewater goby *(Eucyclogobius newberryi)* may occur in downstream reaches of streams originating in or passing through the ownership. Historical data regarding the status of salmon and trout stocks on PL's property are limited. Consequently, much of the analysis of distribution and abundance of these species is based on recent carcass surveys, spawning surveys, and miscellaneous information collected from PL, CDF&G, and Humboldt State University (HSU). Information on the general distribution and abundance of anadromous salmonids within the Pacific Northwest was obtained in Groot and Margolis (1991), Meehan and Bjorn (1991), Nehlsen et al. (1991), Frissel (1993), The Wilderness Society (1993), and Flosi and Reynolds (1994).

SPECIES ACCOUNTS

1. Chinook Salmon (Oncorhynchus tshawytscha)

Chinook salmon are indigenous to the northern half of the Pacific Northwest from the Sacramento-San Joaquin River to the Yukon and Nushagak rivers. The largest rivers tend to support the largest runs of chinook salmon, even though chinook inhabit many smaller systems. Very large runs of chinook salmon were historically present on both the northern and southern extremes of their range, often exceeding numbers seen in systems like the Columbia River located in the middle of their range. In recent decades the abundance of chinook salmon in waters within the continental United States has decreased dramatically.

In response, the NMFS was petitioned to list chinook salmon and to designate critical habitat in California, Oregon, Washington, and Idaho under the ESA (60 FR 30263, 8 June 1995). A finding was made by the Assistant Administrator for Fisheries that a listing may be warranted based upon the petition. Currently, chinook salmon in the southern Oregon and California coastal ESU are ruled "likely to become endangered in the near future," and therefore, as of 9 March 1998, have a status of proposed threatened (63 FR 11492, 9 March 1998).

Nehlsen et al. (1991) identified 64 native stocks of chinook salmon within the Pacific Northwest that are at some risk for extinction. Of the stocks that occur within PL's ownership, Nehlsen et al. (1991) considered fall chinook in the Mattole River to be at "high risk" of extinction and fall chinook in the lower Eel River to be at a "moderate risk" of extinction.

Table 1. Fish species in the SYP/HCP Plan Area.

Federally Protected and Other Fish Species Residing within PL Ownership Boundaries	
Species	**Status**
Chinook salmon *(Oncorhynchus tshawytscha)*	PT
Coho salmon *(O. kisutch)*	FT
Steelhead/rainbow trout *(O. mykiss)*	CS
Coastal cutthroat trout *(O. clarki)*	SR
Pacific lamprey *(Lampetra tridentata)*	*
Coastrange sculpin *(Cottus aleuticus)*	*
Prickly sculpin *(C. asper)*	*
Sacramento sucker *(Catostomus occidentalis humboldtianus)*	*
Sacramento squawfish *(Ptychocheilus grandis)*	*
Threespin stickleback *(Gasterosteus aculeatus)*	*
California roach *(Lavinia symmetricus)*	*

PT = Proposed for listing as a threatened species
SR = Status review currently being conducted by NMFS
FT = Federal threatened species
* = Currently is in no imminent danger
CS = Candidate species, listing decision deferred

Chinook salmon within the WAAs originated from both native and hatchery fish (i.e., are of "mixed origin"). Releases of hatchery raised chinook to the Yager WAA from PL's facility on Cooper Mill Creek have ranged from 2,636 to 85,500 fish/year. These releases have also varied in time, with releases occurring in only 7 of the last 14 years. Releases into the Humboldt WAA have totaled 86,855 fish, and have occurred in five years since 1964. The Eel, Bear-Mattole, and Van Duzen WAAs have not received hatchery plants from PL's facility.

1.1 Abundance/Distribution of Chinook Salmon

The amount of information on the abundance and distribution of chinook salmon in individual WAAs varies greatly. Specific figures for chinook escapement (natural and artificial production combined) on PL's ownership are not available. Consequently, it is not possible to determine the status of this species with certainty. However, the data that do exist suggest that chinook occur in low numbers throughout much of PL's ownership (see Map 16 in Volume V). For example, trapping on Freshwater Creek from 1985 to 1994 resulted in the capture of chinook in each year, but total captures during a limited trapping period never exceeded 37 fish (HFAC 1994). Similarly, the state has commented that chinook escapement is generally thought to be low compared to historical levels, but also considered stable or possibly increasing (S. Downie, CDF&G, pers. comm.). Nehlsen et al. (1991) also reported that fall chinook populations in northern California streams have diminished from historic levels but that most stocks are not in imminent danger of extinction. Trapping efforts by PL have regularly resulted in the capture of chinook salmon, but this effort represents a minimal estimate of abundance because of low trap efficiency and the limited period during which traps are set. Other distribution and abundance data for specific WAAs are presented below:

- **Humboldt WAA.** Surveys conducted by the CDF&G documented chinook utilization of the North Fork of the Elk River within the Humboldt WAA (CDF&G 1995). The survey found 130 (14% of total) and 116 (13%of total) chinook carcasses in the North and South forks of the Elk River, respectively. Chinook salmon are also known to occur in some of the tributaries of both the North and South forks of the Elk River (G. Moody, PL, pers. comm.). In addition, Humboldt State University spawning surveys found 118 chinook salmon in the Freshwater Creek Basin from 1987 to 1988 (Brumback and Ellinwood 1988). This study documented the presence of chinook salmon in Freshwater Creek, Cloney Gulch, and the South Fork of Freshwater Creek. PL biologists have observed chinook salmon in Little Freshwater Creek as well.

- **Yager WAA.** Within the Yager WAA, chinook spawning occurs in the mainstem of Yager and Lawrence creeks. The lower portion of Lawrence Creek, from its junction with Yager Creek and extending upstream to the confluence with Fish Creek, appears to have the highest level of utilization by spawning chinook salmon. Spawning chinook salmon have also been observed in the Corner, Fish, and Shaw Creek tributaries to Lawrence Creek (S. Downie, CDF&G, pers. comm.). A spawning survey in 1979 to 1980 found a similar pattern of chinook spawning; chinook redds and carcasses were observed in the lower four miles of Lawrence Creek, the North and Middle forks and mainstem of Yager Creek, and in Cooper Mill Creek (Winzler and Kelly 1980). The CDF&G's carcass surveys yielded 927 chinook salmon in the Yager WAA from 1987 through 1995, 519 (56%) of which were found in Lawrence Creek (CDF&G 1995).

- **Van Duzen WAA.** Carcass surveys completed by the CDF&G in the Van Duzen WAA suggest that locally abundant chinook populations may be present in this WAA. A total of 909 chinook carcasses were found in the Van Duzen WAA from 1987 to 1995 (CDF&G 1995). Root Creek yielded 55% (533) of the adult chinook carcasses, while Hely Creek and Cummings Creek accounted for 16 percent (149) and 13 percent (114) of the carcasses, respectively. Chinook salmon are known to spawn in the mainstem Van Duzen River from approximately its junction with Little Larabee Creek downstream to the Eel River (S. Downie, CDF&G, pers. comm.). In addition, chinook carcasses were collected in Grizzly and Stevens creeks (CDF&G 1995).

- **Eel WAA.** Carcass surveys indicate chinook salmon spawn within the following tributaries in the Eel WAA: Bear Creek, Carson Creek, Chadd Creek, Jordan Creek, and Larabee Creek (CDF&G 1995). Of the 132 chinook salmon observed from 1987 to 1995, 90 (68%) were found in Bear Creek and 26 (20%) were observed in Chadd Creek. Juvenile salmonid surveys conducted from 1990 through 1994 have not documented the presence of chinook juveniles in the Eel WAA (S. Downie, CDF&G, pers. comm).

- **Bear-Mattole WAA.** No carcass data were collected by the state in the Bear-Mattole WAA. A single juvenile chinook salmon was collected from Rattlesnake Creek in September of 1991 (CDF&G 1995). The lack of juvenile or carcass surveys makes it difficult to determine the importance of this WAA for chinook spawning, but the collection of only a single juvenile suggests that chinook abundance in this WAA is low.

1.2 Habitat Requirements of Chinook Salmon

Adult. Chinook salmon are the largest of all Pacific salmon, and can weigh over 100 pounds. The timing of migration to and from the ocean, and the number of years spent at sea varies according to stock (Figure 1, Figure 2). Chinook stocks containing larger individuals tend to spend more years at sea, while some stocks have a higher percentage of "jacks," fish that spend only one year at sea (Meehan and Bjornn 1991). Beauchamp et al. (1983) describes three life history patterns for this species; spring, summer, and fall chinook salmon with each stock corresponding to a different season in which upstream migration begins. Two behavioral forms are present among chinook salmon stocks: "stream-type" individuals typically spend more than one year in freshwater residency as juveniles before migrating to the ocean, returning as adults to spawn in the spring or summer (Healey 1991), and "Ocean-type" which emerge from their redds and normally spend less than three months in freshwater before migrating to the ocean as juveniles and as adults typically return to freshwater to spawn in the fall (Figure 2).

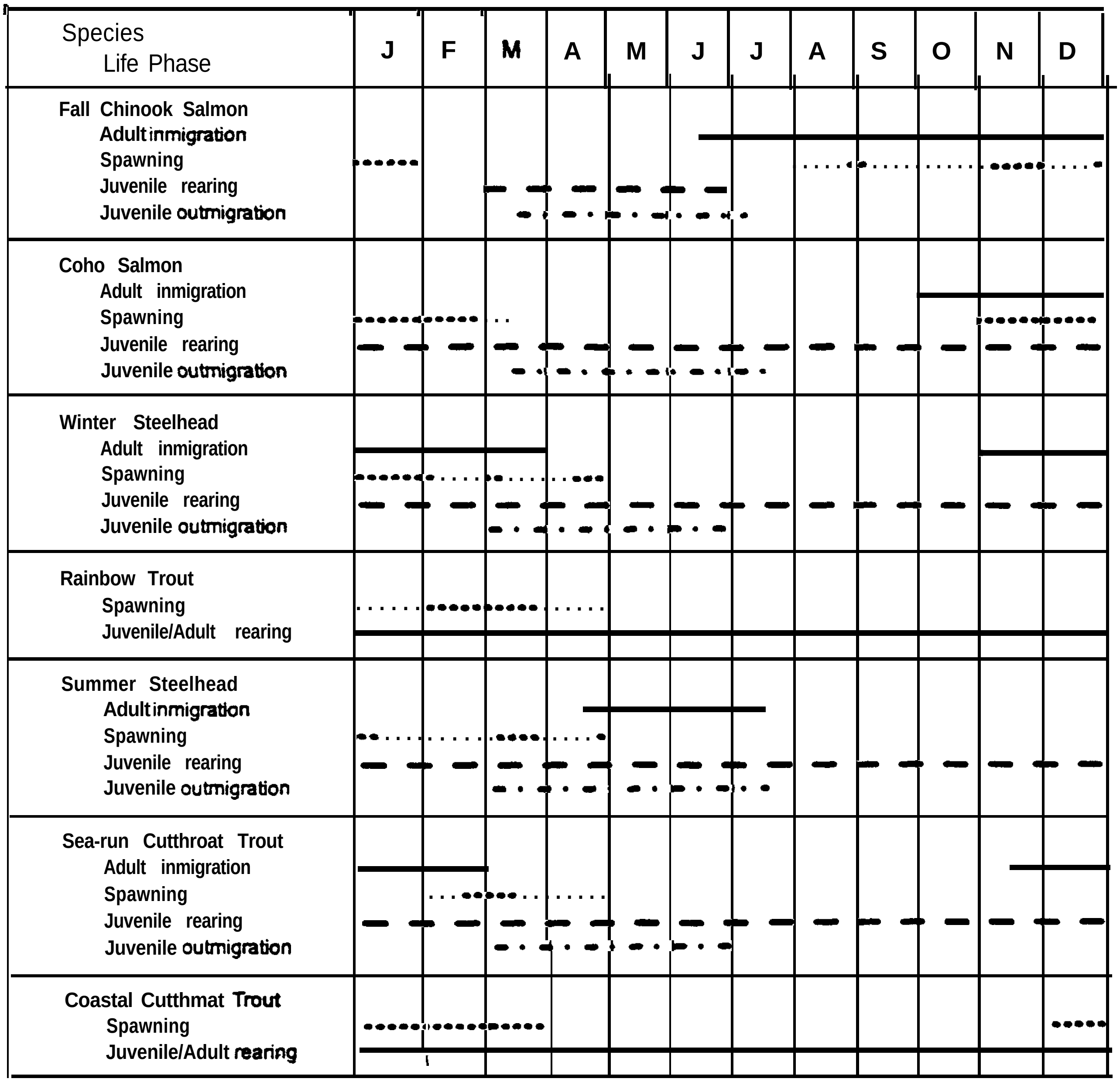
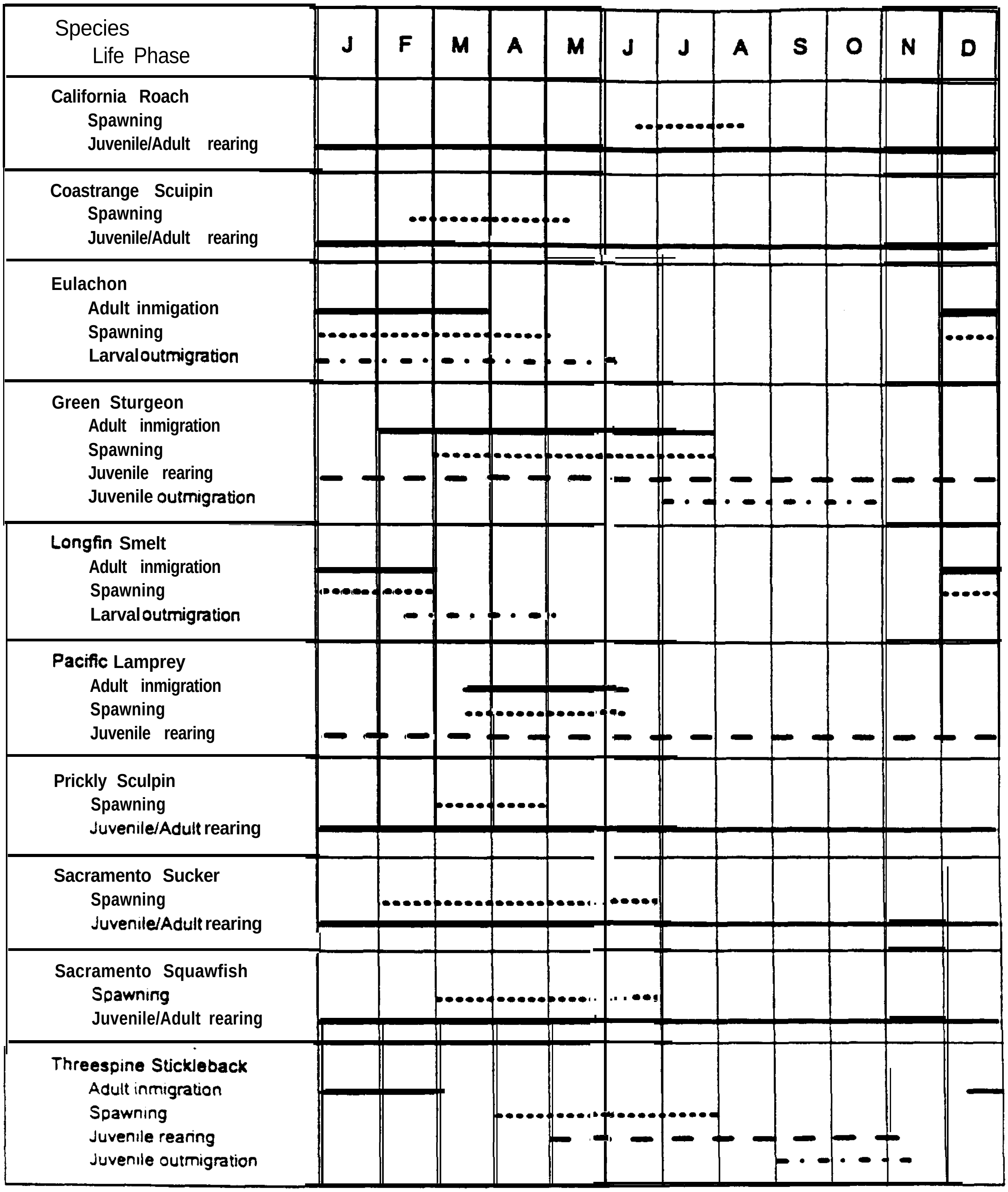


figure 1 Species specific life history chronologies for fish species found on PL's ownership. (Page 1 of 2)

Figure 1 page 2



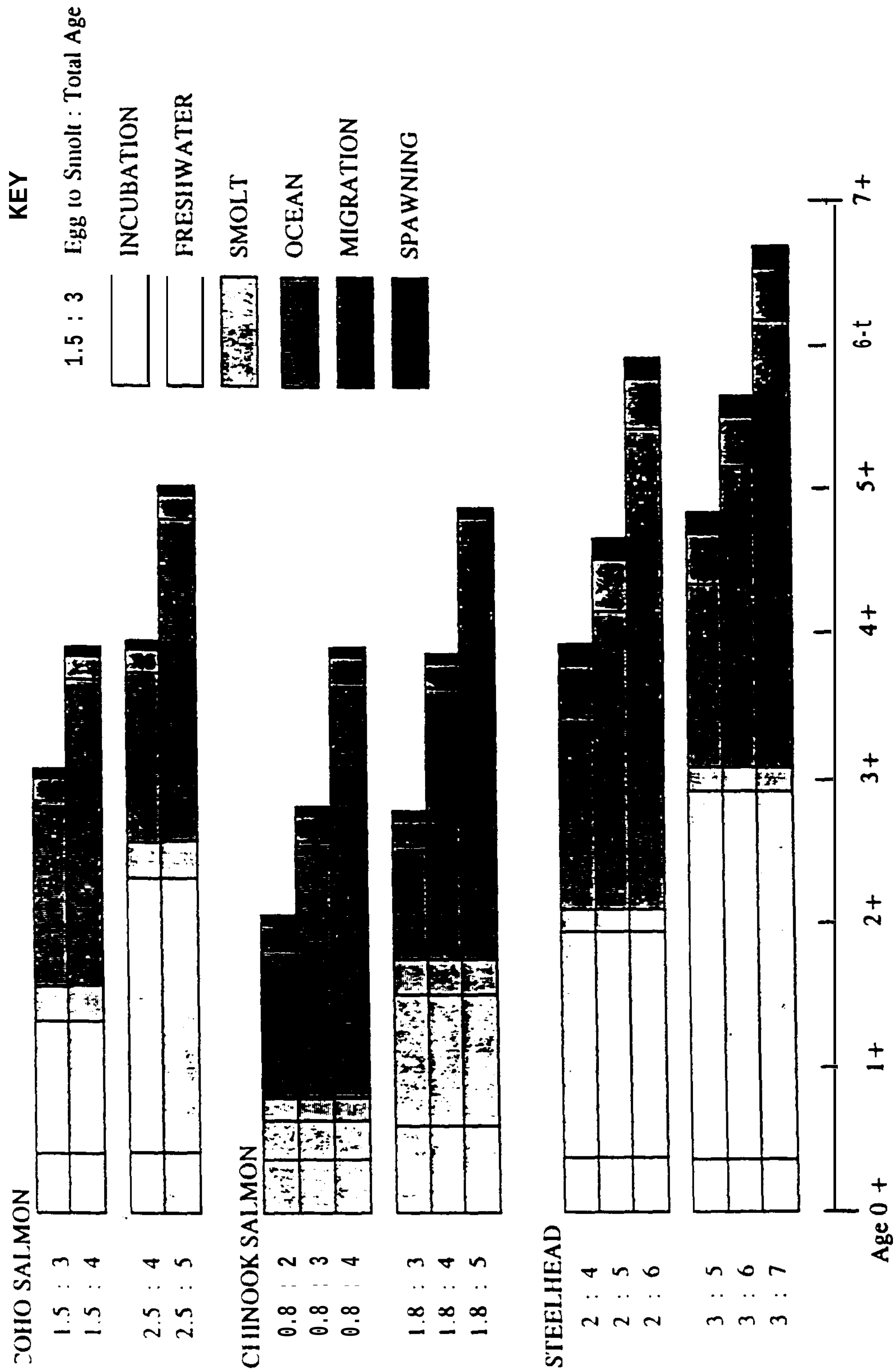


Figure 2 Life history strategies for anadromous fish species in the Pacific Northwest.

The only verified life history pattern within the five WAAs is of fall-run chinook salmon (see Map 16 in Volume V). Adults enter freshwater in October-December and spawning runs typically begin when water levels in streams rise in response to fall rains or, in the Eel River, in response to releases of water from the Pillsbury and Van Arsdale reservoirs. Juveniles within the ownership exhibit the "ocean type" pattern of rearing.

Like all Pacific salmon, mature chinook salmon cease all feeding activities when they enter freshwater to spawn. Upon completion of spawning all chinook salmon die. Because of this relatively short period of freshwater residency, habitat requirements of adult Pacific salmon are limited to spawning and holding cover elements. During the early part of the spawning run, adult chinook often hold in deep pools and runs in the larger rivers or river segments, including the Eel and Van Duzen rivers, and the lower segments of Freshwater Creek and the Elk River.

The suitability of holding water is increased by the presence of cover elements such as submerged rootwads, logs, boulders and deep water. Holding behavior is interspersed with rapid movements upstream to smaller tributaries during short term increases in discharge (the latter again typically resulting from storms). Overall, the most important habitat aspects for adult chinook are the presence of deep holding water, and sufficient discharge to permit upstream movement.

Spawning. Once chinook salmon arrive at their natal (home) streams, they congregate near suitable spawning sites. Like other Pacific salmon, the female selects, excavates, and defends the nest or redd from other salmonids. Chinook spawn over a range of water temperatures varying from 42 to 57°F (Raleigh et al. 1986; Bjornn and Reiser 1991).

Chapman et al. (1986) found chinook spawning in the Columbia River from the water's edge down to 22 ft below the water's surface, while Bjornn and Reiser (1991) listed preferred depths 0.75 ft. Raleigh et al. (1986) state that depth plays a minor role in determination of chinook spawning success, except during extremely low water conditions that may desiccate the redd, stating that minimal depths 0.6 ft and base flows 50 percent of the annual mean daily flow should provide sufficient spawning waters.

Owing to their body size, spawning chinook salmon can utilize larger gravel and cobble substrates ranging from 0.75 to 4.0 in. in diameter (Raleigh et al. 1986). Chapman et al. (1986) found 32 to 35 percent of their redd sediment samples were retained in a sieve size of 3 in, with 5 percent of the material being made up of sediments <0.3 in. Raleigh et al. (1986) hypothesized that substrates of 6 in. in diameter were approaching the upper end of usefulness for chinook salmon.

Water velocity has been proposed as the most important variable in selection of spawning areas by chinook salmon (Raleigh et al. 1986), with an optimal range of 0.98 to 3.0 ft/s. However, Chapman et al. (1986) found water velocities along spawning transects (measured 8-10 in. above the substrate) to be well over 3.3 ft/s.

Incubation temperature regimes for chinook vary from a low of 41°F to a high of 58°F (Bjornn and Reiser 1991). Chinook eggs require 882 to 991 temperature units on average before hatching (1 temperature unit = 1 degree C above freezing for 24 h) (Beauchamp et al. 1983). Fall chinook fry emergence begins in March and is usually complete by late April (Lister and Walker 1966; Lister and Genoe 1970; Moyle 1976). Lister and Genoe (1970) reported that newly emergent chinook fry averaged 1.7 in. fork length.

Juvenile. Immature chinook salmon represent the most diverse group of salmon with respect to the length of freshwater residence (Moyle 1976). Taylor and Larkin (1986) describe both "stream-type" and "ocean-type" juvenile life histories, as noted above. Stream-type individuals tended to stay in freshwater throughout their first summer and winter, with smoltification taking place in the spring at age 1+. Within ocean-type chinook, migration of age-0 fish to saltwater can begin immediately after emergence from spawning gravels, or can occur several months later. Most fall chinook in California begin downstream migration almost immediately (Moyle 1976), and based on records of outmigration (Tom Weseloh, Calif. Trout, and S. Downie, CDF&G, pers. comm.) fall chinook salmon in the five WAAs appear to do the same. The initiation of migration to the ocean may be triggered by environmental cues such as streamflow reductions, changes in photoperiod, and temperature increases (Stein et al. 1972). Lister and Walker (1966) reported freshwater survival rates of chinook fry ranging from 0.2 to 7 percent.

During their freshwater residency, juvenile chinook prefer quiet shallow water with substrates varying from silt to rubble as large as 8 in. in diameter (Everest and Chapman 1972). As fish grow, habitat selection shifts to faster and deeper waters. Stein et al. (1972) and Roper et al. (1994) found a similar affinity of chinook juveniles for deep water habitats in streams in Oregon. Stein et al. (1972) indicate a preference of chinook for backwater eddies, while Roper et al. (1994) found that age-0 chinook heavily concentrate in pool habitats.

Age-0 chinook salmon selected covered over uncovered sections in an artificial stream channel (Brusven et al. 1986). Results from this study and Lister and Genoe (1970) illustrate the importance of cover from undercut banks and overhanging vegetation during summer residency in freshwater. Everest and Chapman (1972) also noticed a shift in habitat use from slow shallow water to faster, deeper water with an increase in age. Hillman et al. (1987) confirmed that age-0 chinook salmon prefer undercut banks, with velocities less than 0.7 ft/s and depths of 8 to 32 in.

Of the three salmon species studied by Levy and Northcote (1982), chinook fry displayed the longest period of residency in tidal channels. Age-0 chinook were present in the Fraser River estuary for at least 1 month, in which time they grew to fork lengths of almost 2.75 in. The authors felt that a short freshwater residency combined with more extended stays in the estuary may benefit chinook by reducing competition with other salmonids in rivers and streams. Moyle (1976) indicates that chinook move "fairly rapidly" through California estuaries, limiting their residency to a one- to two-month period. Even a one-month residency is important, however, because of the significant amount of growth that can occur during this period. Increased growth, in turn, results in higher marine survival rates for the juvenile fish (Simenstad et al. 1982). Consequently, estuaries at the mouth of the Eel, Bear, and Mattole rivers and within Humboldt

Bay are likely to be important in determining the size of populations of chinook salmon in the WAAs.

Larval and adult insects are the dominant food of juvenile chinook salmon during their freshwater residency (Becker 1973; Kjelson et al. 1982), suggesting that juvenile fish feed within the water column on invertebrate drift. Invertebrates also appear to be the dominant dietary item during residence within estuaries. Two studies found that chinook in estuaries fed heavily on chironomid (i.e., midge) larvae, pupae, and adults even when other prey items were available in greater densities (Kjelson et al. 1982; Sheffler et al. 1992).

2. Coho Salmon (*Oncorhynchus kisutch*)

Coho salmon are native to drainages along the Pacific coast from Alaska to California. Historically, coho were abundant in most small coastal streams from northern California to Oregon and Washington, reaching inland to the Columbia and Snake rivers. Numerous stocks have been introduced elsewhere during the past 30 years. Coho salmon are found in a wider variety of habitats than other anadromous salmonids, ranging from small coastal streams to large inland lakes and rivers (Meehan and Bjornn 1991).

On 21 July 1993, NMFS received a petition to list under the ESA five or more ESUs of naturally spawning coho salmon (60 FR 38011, 25 July 1995). The petition, filed by Oregon Trout, Portland Audubon Society, and Siskiyou Regional Education Project included stocks from the rivers south of Cape Blanco, the Coquille and Coos rivers, the Umpqua River, rivers between the Umpqua and Nehalem rivers, and the Columbia River. On 20 October 1993, a petition from Pacific Rivers Council and 22 co-petitioners to list all coho salmon populations in Washington, Idaho, Oregon, and California and designate critical habitat was also received. On 26 January 1994, NMFS published a notice of finding that a non-emergency listing may be warranted. An expanded status review of coho salmon coastwide was then initiated by NMFS. Prior to the above petitions, two additional petitions to list and designate critical habitat for lower Columbia River coho salmon and coho in Scott and Waddell creeks, California were received by NMFS on 11 September 1990 and 18 June 1993, respectively. Both of these petitions were denied on the basis that they did not constitute unique ESUs under the ESA.

A Biological Review Team (BRT) consisting of staff from NMFS was established to author a coastwide status review for coho salmon. The document, entitled “Status Review of Coho Salmon from Washington, Oregon, and California” was completed in September 1995. Based on findings from the status review, NMFS published a proposed listing of six coho ESUs on 25 July 1995 (61 FR 56139, 31 October 1996); The six ESUs were: central California coast, northern California/southern Oregon coasts, Oregon coast, Columbia River/southwest Washington coast, Olympic Peninsula, and the Puget Sound/Straight of Georgia (Figure 3). The central California coast, northern California/southern Oregon coasts, and the Oregon coast ESUs were proposed for listing as threatened under the ESA, while the Puget Sound/Strait of Georgia and the lower Columbia River/southwest Washington coast ESUs were identified as candidates for listing. On 31 October 1996, the central California coast ESU was listed as a threatened species under the ESA (61 FR 56139, 31 October 1996).

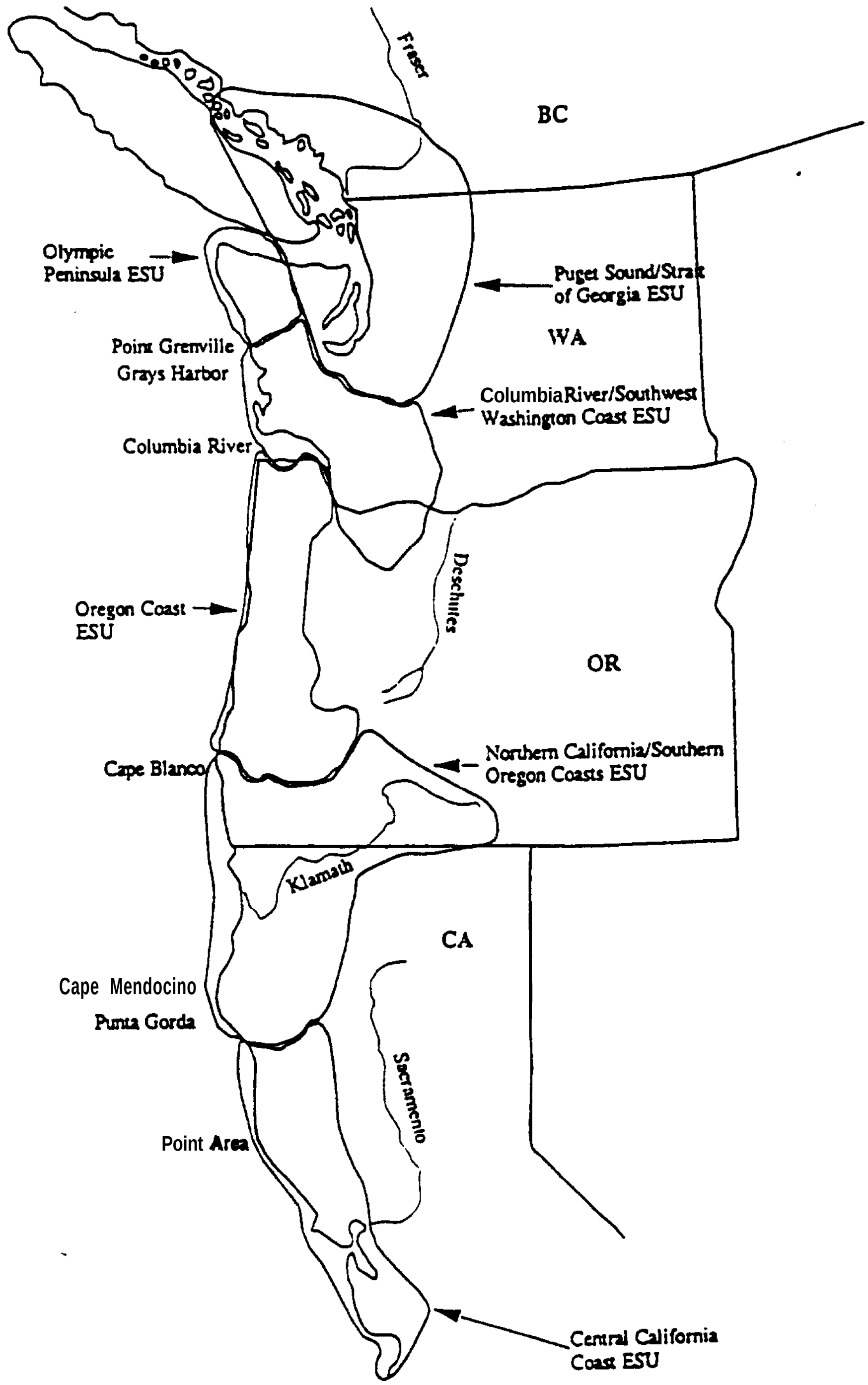


Figure 3 Proposed west coast coho ESUs (adapted from Weitkamp 1995).

Decisions on whether to list the Oregon coast and the northern California/southern Oregon coasts ESUs were delayed for up to 6 months under Section 4(b)(6)(B)(i) of the ESA because of "substantial disagreement regarding the sufficiency or accuracy of the available data relevant to the determination." Subsequently, on April 25 1997, NMFS declared its intention to list coho salmon within the northern California/southern Oregon coast ESU as a threatened species under the ESA. The listing occurred 60 days after this notice. NMFS deferred ruling on the Oregon coast ESU for three years.

All coho populations within PL's ownership belong to the northern California/southern Oregon coasts ESU (Figure 4). NMFS' BRT concluded that the coho salmon in this ESU "are not in danger of extinction but are likely to become endangered in the foreseeable future if present trends continue." Nehlsen et al. (1991) in their review similarly concluded that coho occurring in small northern streams in this region of California were at a moderate rather than high risk of extinction. Although populations may not be in imminent danger of extinction, reductions in the number of coho returning to streams along the north coast are substantial. The CDF&G concluded that natural and hatchery stocks, together, may have declined over 95 percent from their pre-1940 abundances, including a 70 percent decline since the 1960s (CDF&G 1995). For these reasons, coho salmon has been listed in California as a candidate for listing as threatened.

General information on the status of coho stocks within the study area of this Plan is more limited. Coho populations in the Mattole River have been reduced to less than 800 spawning fish (Brown et al. 1994). By contrast, the Eel River probably supports the largest remaining natural population of coho salmon in both the northern California/southern Oregon coasts ESU, and in California as a whole (Brown et al. 1994). Natural production of this species in the Eel drainage is especially significant because coho salmon production in other large rivers in northern California is dominated by hatchery returns (Brown et al. 1994). Although natural production predominates, PL did plant 10,665 coho salmon in the Eel WAA in 1983. Coho salmon within the Yager WAA are also sustained by wild production; no coho salmon from PL's hatchery facility on Cooper Mill Creek have been introduced to the Yager WAA. Coho salmon are common in the Freshwater and Elk River drainages, however, populations in these areas have been supplemented with hatchery fish. PL has planted 174,462 coho in the Humboldt WAA since 1965, and additional plants have been made over several years by the Humboldt Fish Action Council (HFAC 1995). No other WAA received smolts or fry from PL's hatchery.

2.1 Abundance/Distribution of Coho Salmon

Specific figures for coho salmon escapement (natural and artificial production combined) within the WAAs are generally not available. Coho salmon are known or thought to occur in a large number of streams on the ownership (see Map 16 in Volume V). As with chinook salmon, escapement of coho salmon within the WAAs is generally thought to be low, but stable or increasing (S. Downie, CDF&G, pers. comm.). Nehlsen et al. (1991) listed all coho salmon north of San Francisco as stocks of special concern, noting that habitat destruction, modification, or curtailment are the major influences upon population status.

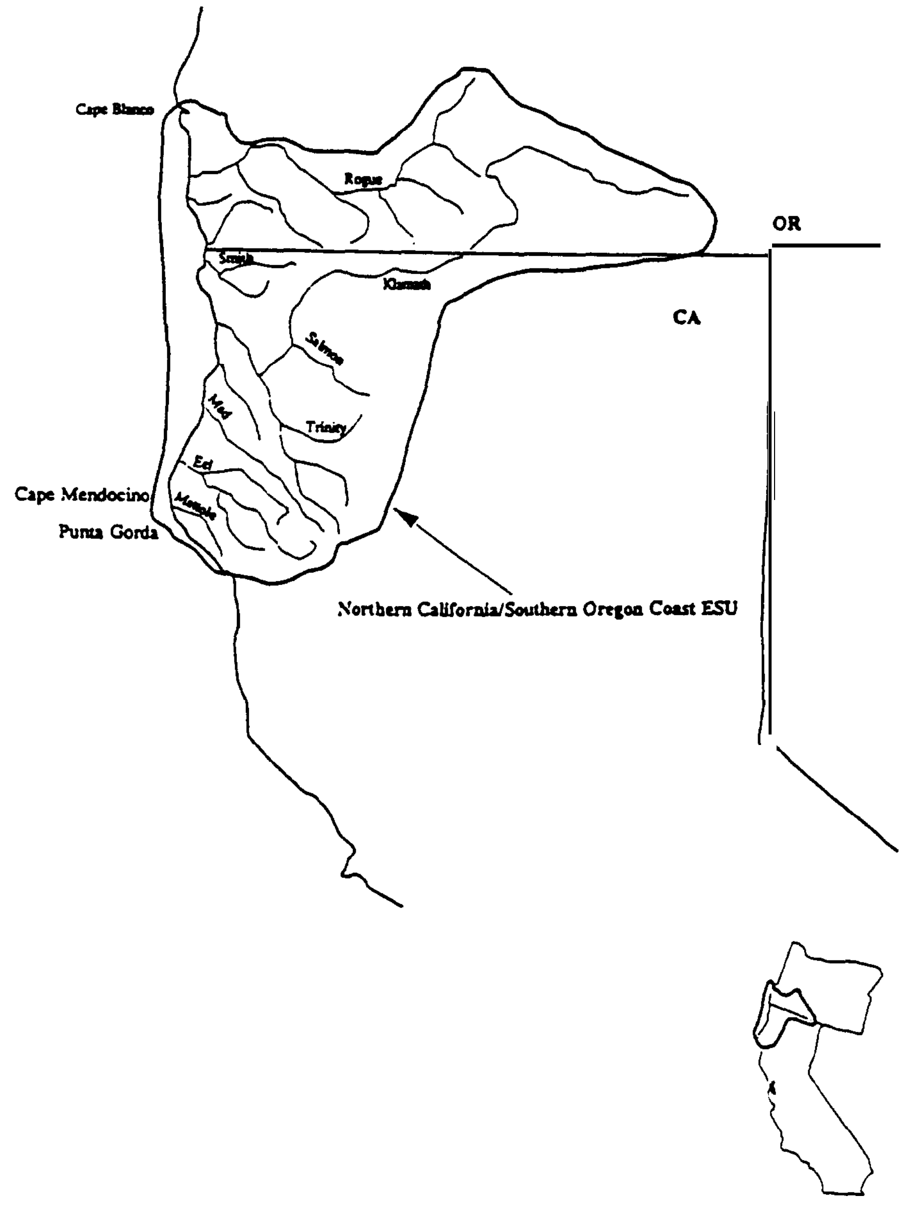


Figure 4 **West coast coho northern California/southern Oregon coast ESU (adapted from Weitkamp 1993).**

Concerns over coho salmon have led the state to close the commercial fishery for this species, which may explain the recent increases in escapement noted below.

Escapement into the Freshwater Creek drainage has been monitored for almost a decade. Total annual captures during a limited trapping period have ranged from 25 to 286 fish (HFAC 1995). The highest escapement levels observed during this period have occurred in the last three years of sampling. In addition, juvenile sampling indicates that coho escapement in Freshwater Creek regularly results in the production of sufficient juveniles to "fully seed" the available habitat, and a similar condition is believed to exist for the Elk River (T. Weseloh, Calif. Trout, pers. comm.). Juvenile coho abundance in 1994 ranged from a low of 1.29 coho/ft^2 in Little Freshwater Creek, to 1.40 coho/ft^2 in Cloney Gulch, and 5.60 coho/ft^2 in Graham Gulch (Preston 1994). These data suggest that coho escapement in the Humboldt WAA is at healthy levels, and may be increasing.

Within the Yager WAA, Pacific Lumber has regularly captured coho salmon within its traps, but the abundance of this species has varied considerably. Trapping efforts in 1994 and 1995 yielded numerous coho salmon in a short period of trapping. These captures represent a minimal estimate of total escapement because of low trap efficiency, and the limited period during which traps are set. Other distribution and abundance data for specific WAAs are presented below:

- **Humboldt WAA**. Carcass surveys conducted by CDF&G within the Humboldt WAA produced 925 adult coho salmon in the North Fork of the Elk River (CDF&G 1995). In addition, juvenile salmon were found in; Bridge Creek, McWhinney Creek, and the North Branch and South Branch of the North Fork of the Elk River (CDF&G 1995). Humboldt State University spawning surveys indicated coho are present within the following tributaries of Freshwater Creek; Cloney Gulch, Falls Gulch, Graham Gulch, and the South Fork of Freshwater Creek (Brumback and Ellinwood 1988). Ongoing surveys by the Humboldt Fish Action Council have documented that coho adults use most accessible portions of the Freshwater Creek drainage (Tom Weseloh, Calif. Trout, pers. comm.).

- **Yager WAA**. Within the Yager WAA, coho spawning occurs in Lawrence Creek and its tributary, Shaw Creek (see Map 16 in Volume V). The CDF&G's carcass surveys within the Yager WAA yielded 14 coho salmon, 5 (35%) of which were found in Lawrence Creek (CDF&G 1995). Juvenile coho can be found throughout streams in the Yager WAA, extending from the spawning areas noted above downstream to the junction with the Van Duzen River. Juvenile coho were collected in 1993 and 1994 from Lawrence Creek (CDF&G 1995).

- **Van Duzen WAA**. Coho distribution in the Van Duzen WAA is somewhat limited in comparison with other WAAs. Carcass surveys have documented adult coho in Cummings and Hely creeks, while juvenile surveys place coho in Grizzly and Stevens creeks (CDF&G 1995).

- **Eel WAA**. Adult coho salmon, as determined by carcass and juvenile surveys, are locally present in the Eel WAA (see Map 16 in Volume V). Coho carcasses have been collected in Bear Creek, Carson Creek, Chadd Creek, and Jordan Creek (CDF&G 1995). Juvenile coho have been captured in Monument Creek (CDF&G 1995) and may be present in tributaries to Larabee Creek (S. Downie, CDF&G, pers. comm.). Juveniles have also been observed in Carson Creek (G. Moody, PL, pers. comm.).

- **Bear-Mattole WAA**. Within this WAA carcass surveys have only been conducted in sections of the Bear and Mattole rivers, which did not contain coho carcasses (CDF&G 1995). Juvenile coho surveys found coho salmon in Rattlesnake Creek (CDF&G 1995).

2.2 Habitat Requirements of Coho Salmon

Adult. Adult coho salmon generally return to their natal streams to spawn at age three, after spending 18 to 24 months (up to 3 years) in the ocean (Figure 2). Some precocial males (jacks) may return to spawn after only a six-month stay at sea. As with chinook, adults require both deep holding cover for resting and sufficient discharge to permit upstream movement. Adult migration in California typically occurs from October through March, and peaks in late-winter (Figure 1) (Brown et al. 1994). McMahon (1983) and Brown et al. (1994) argued that migration barriers and stream accessibility are major factors affecting adult coho on their upstream migrations from saltwater. Groot and Margolis (1991) report coho upstream migrants crossing small obstructions as quickly as possible and then resting in deep pools before they continue their migration to natal spawning areas. Laufle et al. (1986) report minimum depths of 0.6 ft and maximum velocities less than 8 ft/s are needed for upstream migration. Cover requirements for coho salmon are similar to those for adult chinook salmon, with deep pools, submerged logs, and rocks providing refuge for adults on their way to spawning grounds.

Spawning. Spawning of most coho stocks occurs between October and March (Figure 1)(Groot and Margolis 1991; Brown et al. 1994). Water temperature at the time of spawning varies from 40 to 49°F (Laufle et al. 1986). Bjornn and Reiser (1991) reported depths 0.6 ft and velocities from 1 to 3 ft/s as suitable for coho salmon spawning areas, while substrate size varied from 0.5 to 4 in. in the same report. Groot and Margolis (1991) report spawning occurring in gravel substrate, the majority of which is less than 6 in. in diameter.

Incubation periods for coho salmon are reported to last from 35 to 101 days (McMahon 1983; Laufle et al. 1986). After hatching, larvae typically spend 2 to 3 weeks (depending on food stored in the yolk sac) absorbing the yolk sac in the gravels of the redd before they emerge in early March to mid-May (McMahon 1983; Laufle et al. 1986).

Juvenile. Upon emergence from the gravels, coho fry migrate to the lateral areas of the stream where they are associated with bank cover, often in the form of large woody debris Lister and (Genoe 1970; Stein et al. 1972; Bisson et al. 1982). Nickelson et al. (1992) found fry residing in backwater pools during the spring, maintaining their association with pools in the summer, and moving to alcoves and beaver ponds during the winter. Bisson et al. (1988) reported age-0 coho inhabiting most pool types while displaying an avoidance for riffle and glide habitats of low gradient. Mason and Chapman (1965) reported similar summer habitats, and noted active defense of feeding territories within two weeks after emergence. Stein et al. (1972) suggest that juvenile coho can out-compete juvenile chinook of the same age. Competitive dominance of coho over steelhead has also been documented (Everest and Chapman 1972).

Complex woody debris structures and side channels are important habitat elements for coho salmon, particularly during the winter (Bustard and Narver 1975a, 1975b; McMahon and Hartman 1989; Shirvell 1990). These studies suggest that the abundance of juvenile coho is often determined by the density of these habitat features. The importance of these habitats increases during the winter because coho move closer to cover in the form of logs, rootwads, debris, and overhanging vegetation as water temperature decreases (Bustard and Narver 1975a, 1975b).

Most juvenile coho reside within freshwater systems for at least a year before migrating to the ocean (Figure 2)(McMahon 1983; Laufle et al. 1986). Laufle et al. (1986) indicate that size and age trigger migration to the ocean, while McMahon (1983) found that size alone was the key factor initiating seaward migrations. At least some coho probably migrate to the sea soon after emergence. Outmigration of coho fry and parr has been observed in Freshwater Creek (T. Weseloh, Calif. Trout, pers. comm.), and may indicate early migration of coho from streams on PL's ownership that have large juvenile populations. Similarly, Tschaplinski (1987) discovered fry inhabiting an estuary within one week after they emerged from gravels in upstream areas. Fry remained in the estuary in late summer, outgrowing comparably-aged fry in the stream by 1.8- to 2.3-fold, and often growing as large as the age-1 smolts that had reared exclusively in freshwater. Tschaplinski (1987) indicated that extended estuarine residence could provide large numbers of smolts to the fishery, with the importance of these estuary origin fish increasing in importance when low numbers are produced in freshwater.

Juvenile coho feed upon aquatic and terrestrial insects while residing in freshwater, although cladoceran zooplankton can also be an important food source in lakes (Meehan and Bjornn 1991). Coho prefer to feed upon drift, commonly utilizing food in suspension or at the water's surface (Sandercock 1991). As yearlings, coho may start to prey upon fry of their own or other species.

3. Steelhead Trout/Rainbow Trout (*Oncorhynchus mykiss*)

Steelhead trout, the anadromous form of rainbow trout, are native to the rivers and streams of the Pacific Northwest from California to Alaska. Resident forms, commonly called rainbow or redband trout, share the same native distribution. The relationship between the two forms is poorly understood (61 FR, 9 August 1996). Accordingly, discussion of resident fish has been included within the analysis of steelhead in the text that follows. Steelhead of the Pacific Northwest have also been placed into two genetic groups, coastal and an inland group (61 FR, 9 August 1996). Both groupings refer to anadromous and resident forms of rainbow trout. Coastal and inland groups are present in Washington and Oregon, while California and Idaho contain only coastal and inland groups, respectively. Finally, steelhead are classified as winter run or summer run, depending on the timing of adult spawning migrations (Figure 1).

The NMFS received a petition to list the Illinois River winter steelhead from 11 parties on 5 May 1992. A response was given on 31 July 1992 by NMFS indicating that a listing may be warranted, launching a status review (61 FR, 9 August 1996). The status review resulted in a ruling by NMFS that said that the Illinois River winter steelhead did not represent a species under the ESA (61 FR, 9 August 1996). However, in that ruling, NMFS indicated that they would be conducting an expanded status review, covering all steelhead stocks in California, Oregon, Washington, and Idaho. On 16 March 1995 listing of the Klamath Mountains Province steelhead ESU under the ESA was proposed (60 FR 14253, 16 March 1995).

The coastwide status review for steelhead was completed, and a proposed ruling and request for comments published on 10 March 1998 (FR vol. 63 11798 10 March 1998) The BRT identified 15 ESUs for steelhead in the Pacific Northwest, 12 coastal forms and 3 inland forms (Figure 5). Of these, two ESUs were proposed as threatened, the Middle Columbia River in Washington and Oregon, and the Upper Willamette River located in Oregon. The final ruling on 19 March 1998 (63 FR 13347, 19 March 1998) listed the lower Columbia, and Central Valley, California ESUs as threatened under the Endangered Species Act.

All PL lands supporting steelhead trout production are contained within the northern California ESU (Figure 6). NMFS did not consider this ESU to be in imminent danger of extinction, but did classify it as likely to become endangered in the future. Nehlsen et al. (1991) similarly identified summer steelhead stocks in the Mad and Eel rivers and Redwood Creek as being at risk of becoming extinct. On 11 August 1997, NMFS indicated that it would defer a listing decision on the Northern California ESU for six months because of “considerable scientific disagreement about the status of the stock[ ].” On 19 March 1998, the NMFS determined that the Northern California ESUs do not warrant listing at this time, and they will reevaluate the status of these ESUs within four years to determine whether listing is warranted (63 FR 13347, 19 March 1998).

General information on the status of populations within the study area of the PLAN are limited. Busby et al. (1996), in their detailed look at the northern California ESU, indicated that most stocks within this unit are depressed, with the only stable population being winter steelhead in the Little Van Duzen River. Within the Eel River drainage long-term escapement data indicate a decline in steelhead abundance. However, since 1970 the data show a “nonsignificant” decline in escapement, indicating that most of the decline in steelhead abundance occurred before 1970 and that populations have been fairly stable since that time (Busby et al. 1996).

Steelhead trout within PL’s ownership are of mixed origin, with a small proportion of the run composed of adult returns of hatchery origin. Releases of hatchery raised steelhead to the Yager WAA from PL’s facility on Cooper Mill Creek have ranged from 3,427 to 30,000 fish/year. Hatchery reared steelhead have been introduced into the Yager WAA 7 times in the last 15 years. The Eel WAA is the only other area to receive hatchery supplementation from PL’s facilities. Busby et al. (1996) list hatchery fish as widespread throughout the ESU, leading the authors to express a concern about the genetic integrity of all steelhead populations within the northern California ESU.

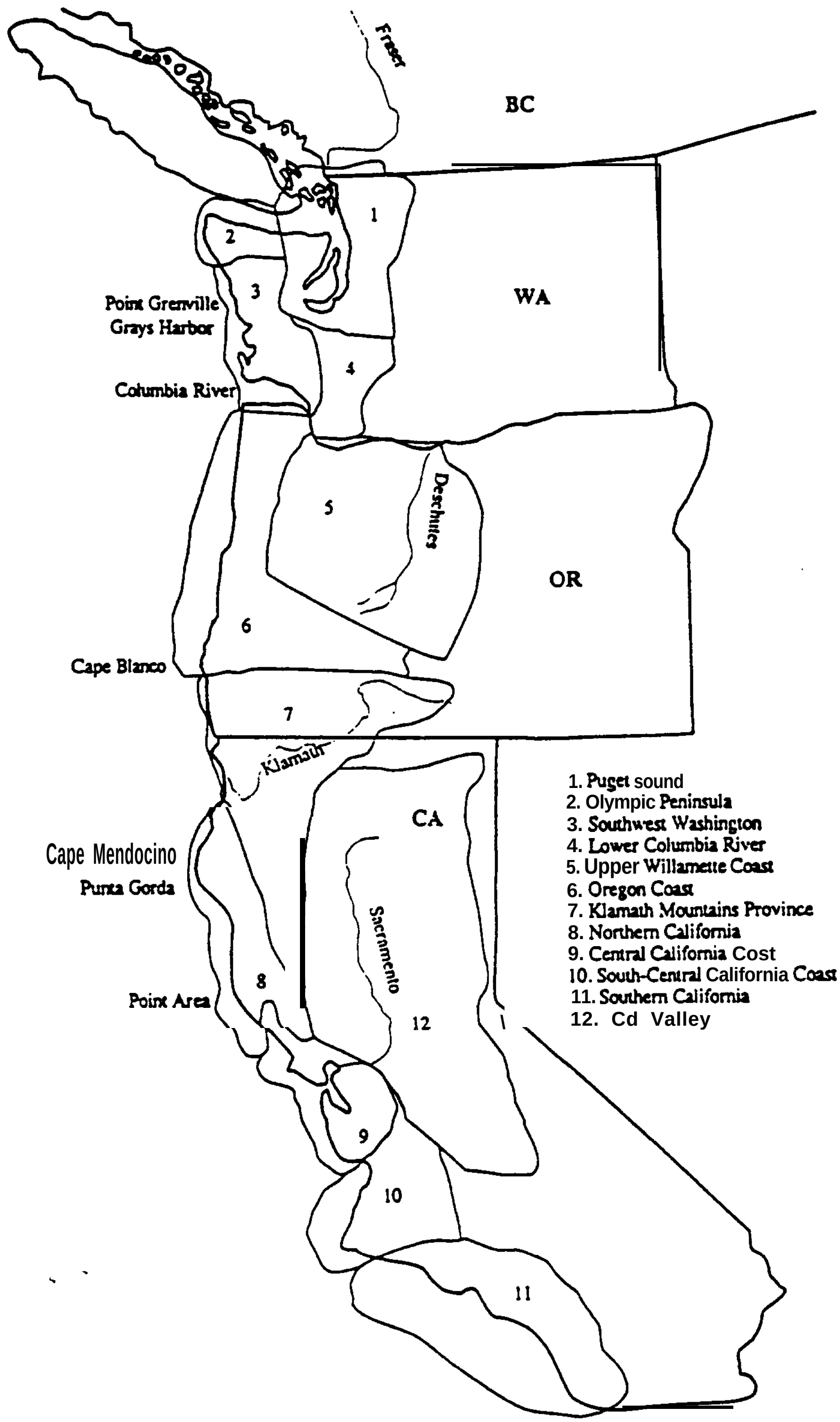


Figure 5 **West coast steelhead ESUs current as of August 1997. (Note: ESU's updated in 1998 and now reflect 15 ESU's) (adapted from Busby 1996).**

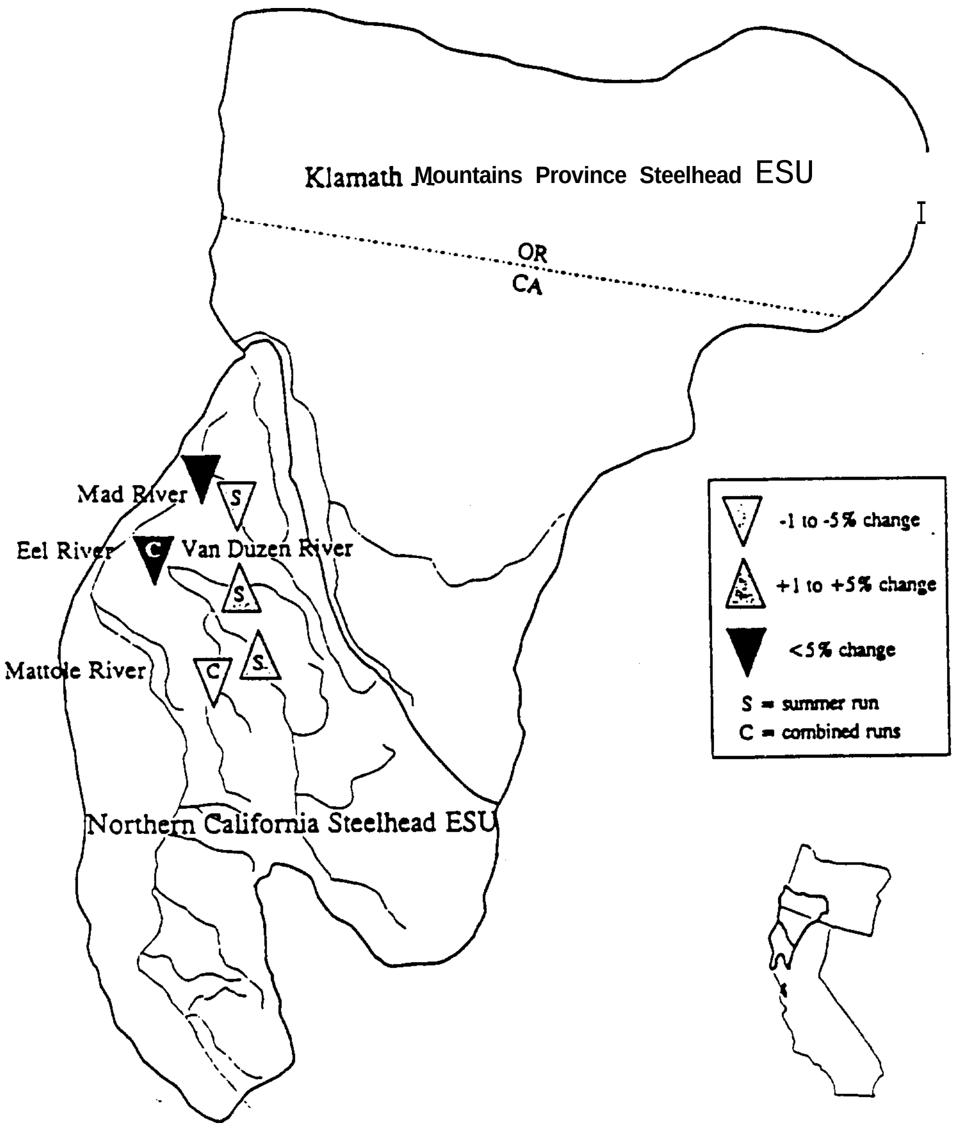


Figure 6 **Steelhead ESUs in the area covered by PL's MSHCP and percent annual change in total escapement for steelhead in northern California ESU.**

3.1 Abundance/Distribution of Steelhead Trout

Steelhead trout are the most widely distributed anadromous salmonid on PL's ownership (see Map 16 in Volume V). In part, this is due to the superior swimming and leaping abilities of steelhead, which allow adults to travel past barriers that impede other salmonids (Powers and Orsborne 1985). However, steelhead also differ from chinook and coho in that they spawn in the spring (Figure 1). This spring spawning confers some protection to steelhead eggs from flood related scour and sediment transport, which occurs primarily during the winter in the rainfall dominated (versus snow dominated) lands that comprise PL's ownership. Within the upper Eel WAA, distribution is limited by the significant barrier to migration presented by Scott Dam (Busby et al. 1996).

The only quantitative estimates of adult escapement for PL's ownership identified to date were for the Humboldt WAA. Adult trapping in Freshwater Creek from 1985 to 1995 resulted in the capture of steelhead in 5 of the 10 years sampled (HFAC 1995). However, trapping by HFAC occurs before the main migration period for winter steelhead, so these efforts represent minimal estimates of escapement. Studies of juvenile steelhead abundance in the Humboldt WAA identified 1.18 steelhead/ft^2 in Cloney Gulch, 3.34 steelhead/ft^2 in Little Freshwater Creek, and 2.80 steelhead/ft^2 in Graham Gulch during 1994 (Preston 1994). Juvenile steelhead are also widely distributed within the Yager WAA, potentially occurring in all stream sections from the spawning areas noted above downstream to the junction with the Van Duzen River. Juvenile steelhead were collected in the following tributaries within the Yager WAA in 1993 and 1994: Bell, Blanton, Booth's Run, Cooper Mill, Corner, Fish, Lawrence, Middle Fork of Yager, North Fork of Yager, South Fork of Yager, Strawberry, and Yager Creeks (CDF&G 1995). Winzler and Kelly (1980) reported collecting steelhead juveniles from 11 of the 12 study sections they sampled in the Yager WAA, and from a 2,000-ft section of Booths Run Creek. Based on these collections, they concluded that the upper reaches of the Yager Creek drainage were an important nursery site for juvenile salmonids. Other distribution and abundance data for specific WAAs are presented below:

- **Humboldt WAA**. Fifty-six adult steelhead were observed in the North Fork of the Elk River within the Humboldt WAA (CDF&G 1995). Both adult trapping and juvenile salmonid surveys indicate that steelhead are present in the Freshwater Creek Basin, including Cloney Gulch, Little Freshwater Creek, and Graham Gulch (Preston 1994; HFAC 1995).

- **Yager WAA**. Within the Yager WAA, steelhead spawning occurs in the upper mainstem of Yager and Lawrence creeks, and in many tributaries to both these drainages. The upper portion of Lawrence Creek, from its junction with Booths Run Creek and extending upstream appears to have a high level of utilization by spawning steelhead. Past surveys by CDF&G identified 32 steelhead adults in the Yager WAA, 6 (19%) of which were found in Lawrence Creek (CDF&G 1995).

- **Van Duzen WAA**. Within this WAA all streams surveyed by CDF&G on PL's ownership contained steelhead. Cummings, Grizzly, Hely, Root, and Stevens creeks all contained steelhead juveniles and/or adults (CDF&G 1995).

- **Eel WAA**. Steelhead, as determined by adult and juvenile surveys, are present in the following streams within the Eel WAA: Atwell Creek, Bear Creek, Carson Creek, Chadd Creek, Dinner Creek, Greenlaw Creek, Jordan Creek, Kiler Creek, Larabee Creek, Monument Creek, Nanning Creek, Shively Creek, Stitz Creek, Thompson Creek, Twin Creek, and Weber Creek (CDF&G 1995).

- **Bear-Mattole WAA**. As with other species, data on fish presence and abundance in the Mattole WAA are limited. The existing data indicate that steelhead are present in Rattlesnake Creek and the Mattole River (CDF&G 1995). The Bear River also contains steelhead.

3.2 Habitat Requirements of Steelhead

Adult. Steelhead are iteroparous (repeat spawners), and can spend a large percentage of their life (2-3 years) in saltwater (Figure 2) (Emmett et al. 1991). While capable of spawning more than once, steelhead rarely spawn more than twice before dying (Busby et al. 1996). As with chinook salmon, runs of steelhead trout are generally named for the season in which they occur or peak. There are two types of runs of Pacific Northwest steelhead, winter run fish migrate into freshwater during the fall and winter, while summer run fish enter freshwater during the spring and summer (Figure 1) (Pauley et al. 1986). Some basins contain both runs, while other basins have only a single run (Busby et al. 1996.). Where both runs are present the result can be that adult steelhead are present in freshwater during most or all of the year.

Steelhead may also be divided into two reproductive ecotypes based on sexual maturity when they enter fresh water (Busby et al. 1996). Fish that enter fresh water while still sexually immature are called "stream-maturing," while "ocean maturing" steelhead enter fresh water with well developed reproductive tissues. Inland forms of steelhead trout are further segregated into "A" and "B" run steelhead. Adult A-run fish enter fresh water from June to August, while B-run steelhead enter fresh water from late August to October (Busby et al. 1996). The "half-pounder" terminology was introduced in the 1920s to describe runs of steelhead that enter fresh water after only 2 to 4 months at sea (Busby et al. 1996). Half-pounders are generally less than 15 in. in length, and there is no consensus among experts as to why this life history strategy exists.

Summer run steelhead typically enter freshwater in spring and early summer and migrate inland to deep, protected holding waters in larger streams and rivers, where they remain for the summer and fall months. Summer steelhead resume their upstream spawning migrations the following winter (late) or spring (early). Winter run steelhead, by contrast, return to fresh water in late autumn/early winter, do not have an extended freshwater residency, and, like summer steelhead, generally reach their natal streams by late winter or early spring (Figure 1). Optimal adult habitat consists of riffle and run habitats interspersed with areas of deep, slow water and abundant instream cover (Raleigh et al. 1984).

Spawning. Water temperatures vary from 39 to 49°F during spawning, with preferred water velocities from 1.3 to 3.0 ft/s (Bjornn and Reiser 1991). Steelhead select gravels from 0.5 to 4.5 in. in diameter, and depths of 0.2 to 1.0 ft to construct their redds (Pauley et al. 1986). Eggs typically hatch in 4 to 7 weeks, with emergence taking place 3 to 7 days thereafter (Pauley et al. 1986). Spawning may occur in coastal or headwater streams, depending on form. The timing of peak spawning is generally the same in a given stream from year to year, although minor adjustments based on changes in local conditions are common (Meehan and Bjornn 1991).

Juvenile. Everest and Chapman (1972) found age-0 steelhead residing over cobbles in water velocities of <0.5 ft/s and depths of 0.5 to 1.0 ft. Bisson et al. (1982) reported fry inhabiting riffles associated with LWD. Age-0 steelhead did not display significant correlation between habitat use and depth or velocity in small streams in western Washington (Bisson et al. 1988). Johnson (1985) found that preferred habitat changed as gradient increased; densities of steelhead juveniles were positively correlated with stream slope. In general, steelhead differ from chinook and coho salmon in their extensive use of faster, shallower, and higher gradient locations in streams, although it is not clear that this habitat type is preferred (Everest and Chapman 1972). The ability of steelhead to use such habitats may explain, in part, why this species can persist in impacted streams that are no longer used by salmon species.

A shift in habitat occurs as juveniles age, with individuals moving into deeper and swifter water (Everest and Chapman 1972; Bisson et al. 1982). Bustard and Narver (1975) found age-0 fry associated with rubble, while age-1 steelhead hid in submerged rootwads and under logs and debris. As water temperatures fell, juvenile steelhead in Carnation Creek moved into deeper water (Bustard and Narver 1975). Bisson et al. (1988) found age-1 steelhead in a variety of velocities, tending to display a preference for pools containing localized areas of swift water. Most steelhead juveniles reside in freshwater from 1 to 4 years before migrating to saltwater (Figure 2), with the majority of hatchery stocks migrating to the ocean at the end of their first year (Pauley et al. 1986).

4. Coastal Cutthroat Trout (*Oncorhynchus clarki*)

The coastal cutthroat trout is native to North America along the western coast from northern California's Eel River to Prince William Sound, Alaska (61 FR 41515, 9 August 1996). Differences in life history, biochemical make-up, chromosome numbers, and coloration distinguish the coastal cutthroat trout from other *O. clarki* subspecies. Anadromous forms are silver in color and lack the characteristic heavy spotting and "darker" overall coloration of the resident forms (ODFW 1995). Coastal cutthroat trout are rarely found more than 100 miles inland and are typically found within 25 miles of the coast in Northern California (Flosi & Reynolds 1994).

The Secretary of Commerce received a petition from the Oregon Natural Resources Council and the Wilderness Society to list the Umpqua River coastal cutthroat trout and designate critical habitat on 1 April 1993 (61 FR 41515, 9 August 1996). On 19 July 1993, NMFS called for a status review on the Umpqua River coastal cutthroat. On 8 July 1994, the NMFS proposed the Umpqua River coastal cutthroat trout as an endangered species under the ESA (61 FR 41515, 9 August 1996). A public hearing was held on 29 September 1994 to gather public comments on the proposed rule. On 9 August 1996 a final ruling on the Umpqua River coastal cutthroat trout was published in which this population was listed as endangered (61 FR 41514, 9 August 1996). Subsequently, a BRT has been identified to produce a status review for all coastal cutthroat trout populations. The review is in process and should be finalized in 1998 (Jim Lynch, NMFS, pers. comm.).

4.1. Abundance/Distribution of Coastal Cutthroat Trout

Virtually no data are available to determine the general abundance or distribution of coastal cutthroat trout within streams on PL's ownership. Anadromous forms of coastal cutthroat trout are present in the Eel River (ODFW 1995). The Humboldt Fish Action Council has collected sea-run cutthroat trout in the Freshwater Creek drainage (Tom Weseloh, Calif. Trout, pers. comm.), but data pertaining to the abundance, distribution, and status of this species within PL's lands are lacking to date. Coastal cutthroat have also been collected from Strongs Creek in the Eel WAA. However, this absence of information is typical for anadromous cutthroat trout throughout their range. Moyle (1976) indicates that coastal cutthroat trout in northern California are less abundant that anadromous and resident rainbow trout, and probably always have been.

4.2. Habitat Requirements of Coastal Cutthroat Trout

Adult. Anadromous forms of coastal cutthroat trout, commonly referred to as sea-run cutthroat, are usually smaller than other anadromous salmonids, and rarely exceed 20 in. in length (ODFW 1995). Like steelhead, cutthroat trout are iteroparous, individuals have been documented spawning for more than 6 years (Figure 2) (Johnson et al. 1994). Life history strategies for coastal cutthroat trout are highly variable. The following are all patterns that have been described for coastal cutthroat trout (source ODFW 1995):

- **Anadromous**. After up to 4 years of rearing within streams, sea-run cutthroat trout migrate to the ocean and remain there for periods of less than one year. Sea-run cutthroat trout usually spawn during the first spring after their return from the ocean or may undergo a second migration to the ocean before spawning.

- **Fluvial**. Coastal cutthroat in this group reside in flowing fresh water for their entire lives. Migrations within streams and rivers do take place, but fluvial cutthroat trout do not have a residency phase in either lakes or the ocean.

- **Adfluvial**. These populations of coastal cutthroat trout migrate between lacustrine (lake/reservoir) and fluvial habitats. Juveniles spend a limited or extended period rearing in fluvial habitats before entering a lake or reservoir. Spawning adults typically swim back upstream into fluvial habitats to spawn.

All of the above life history forms may be present within a basin, often sympatric in the same river. Fluvial and anadromous forms within the same drainage are often, but not always, segregated by the presence of non-passable fish barriers (Moyle 1976). The level of gene flow between life history forms is not understood at present (ODFW 1995).

Little is known about the habitat use of sea-run cutthroat trout during their freshwater residency (Johnson et al. 1994; ODFW 1995). Habitat use by coastal cutthroat trout is believed to be similar to that for rainbow trout, which have been more thoroughly studied (Moyle 1976). Adults appear to spawn in small streams, and fry tend to move to the stream margin after swim-up. Winter habitat for juveniles consists of pools and side channels in association with woody debris (ODFW 1995).

During the marine phase of their life cycle, juvenile and adult sea-run cutthroat trout appear to use waters near the shore, usually in areas relatively near their natal streams (Moyle 1976; ODFW 1995) Both gravel beaches with upland vegetation, and nearshore areas containing large logs and other LWD are used during the marine residency phase.

5. Pacific Lamprey (*Lampetra tridentata*)

The Pacific lamprey can be found in coastal streams from southern California to Alaska (Morrow 1980). Like other lampreys, adults are parasitic in marine environments, entering freshwater to spawn (Wydoski and Whitney 1979). Adult Pacific lamprey migrate upstream in spring and early summer in search or spawning areas. Pacific lamprey have spawning habitat requirements similar to those of the coho salmon (see above description of coho salmon habitat requirements). Both sexes work to construct a shallow nest in stream gravels (Morrow 1980). The female then attaches herself to a rock with her oral sucker while the male attaches to the head of the female. The male and the female vibrate wildly while the eggs and sperm are released. The fertilized eggs adhere to the downstream portion of the nest (Moyle 1976). Eggs are then covered by the adults. The process is repeated several times in the same nest site, with death occurring shortly after (Moyle 1976).

The larvae hatch in 2 to 3 weeks and remain in the nest about 3 more weeks (Walden 1964). Juvenile lamprey, called ammocoetes, swim out of the nest and are washed downstream to a slow current area with a sufficient accumulation of silt and sand, where they burrow, tail first, into the substrate (Hardisty 1979). Ammocoetes cement the walls of the burrow with mucous secretions. The larvae use an oral hood covered in mucous that protrudes from the substrate to catch organic matter and algae for food (Moyle 1976; Hardisty 1979). Ammocoetes are unable to osmoregulate in sea water until after metamorphosis (Morris 1972; Beamish 1980). The ammocoetes generally remain in fresh water for five to seven years before undergoing metamorphosis and migrating to the ocean (Wydoski and Whitney 1979; Beamish and Levings 1991; Whyte et al. 1993). Such an extended freshwater residence makes them especially vulnerable to degraded stream and water quality conditions (Hardisty 1979).

Shortly after reaching the ocean they attach to a host and inflict a puncturing wound from which they suck the blood and body fluids of the host (Youson 1981; Moyle 1976). Adults live in the ocean about a year before starting upstream to reproduce at which time the adults experience many changes (Beamish and Levings 1991; Whyte et al. 1993). There is some uncertainty as to what triggers these changes, but temperature is suspected. At the time of upstream migration the adult loses its ability to osmoregulate in sea water, develops gonads, stops eating and its digestive system begins to atrophy (Whyte et al. 1993). These adults spend up to a year in fresh water before reproducing (Whyte et al. 1993).

The Pacific lamprey tends to be nocturnal in the fresh water phases of its lifecycle (with the exception of the period just before reproduction) and diurnal in the ocean (Hardisty 1979). Ammocoetes, newly metamorphosed adults, and migrating adults have been found to be more active nocturnally (Joss and Potter 1982; Beamish and Levings 1991). In fact ammocoetes retreat further into their burrows in the presence of light (Hardisty 1979) but they will leave their burrows at night to swim in the water column (Hardisty 1979). The exception to nocturnal activity is that lamprey typically chose spawning grounds in full sunlight and therefore spend the time just before spawning in light areas (Hardisty 1979). Adults in the ocean are more active diurnally. Laboratory studies have shown that adult lamprey use both vision and olfactory sense to locate potential hosts (Hardisty and Potter 1971).

There seems to be some question as to whether Pacific lamprey parasitism has a significant impact on commercial fisheries, specifically on salmon (Beamish and Levings 1991). Although few studies have been done to determine the feeding preference of Pacific lamprey, when offered herring and salmon in one study more herring were fed from than salmon (Beamish and Levings 1991). Moyle and Cesh (1988) describe lampreys as being “prudent” predators in that they do not seriously deplete the populations of their prey species. The manner in which the Pacific lamprey feeds allows the host to live to reproduce.

Given the conditions of the streams on PL’s property, many reaches do not have habitat appropriate for ammocoetes (i.e., slow reaches containing mud and substrates). Conditions appropriate for ammocoetes rearing do exist downstream in lower reaches of some streams off PL property. There are many streams on the ownership where suitable spawning conditions are available, in particular cobble and gravel substrates that are relatively free of fine sediments.

6. Coastrange Sculpin (*Cottus aleuticus*)

This small sculpin species is a resident of small coastal streams from Morrow Bay, California north to Alaska (McGinnis 1984). Less abundant than the prickly sculpin, this sculpin usually occupies fairly large streams with moderate to rapid currents. Active at night, the coastrange sculpin generally resides in the clean gravels or cobbles in flowing water. California and Oregon coastrange sculpins typically spawn at age-3 in the spring, peaking in March and April (Figures 1 and 2) (Moyle 1976; Wydoski and Whitney 1979). The coastrange sculpin usually migrates to spawning areas containing large flat rocks and medium current (Moyle 1976). Nest preparation is done by the male which is territorial only during the breeding season. The female is escorted to the nest where the adhesive eggs are deposited under rocks. The female is driven from the nest after spawning and the male may attract another female to spawn in the same nest. The typical female averages about 1,000 eggs (McGinnis 1984). The pelagic juveniles generally live in slower areas of the stream or in lakes, floating to these areas shortly after hatching (Wydoski and Whitney 1979). Aquatic insect larvae and other macroinvertebrates generally dominate the food of coastrange sculpins (Moyle 1976).

7. Prickly Sculpin (*Cottus asper*)

The prickly sculpin, the most widely distributed sculpin in California, ranges from the Ventura River, California to Seward, Alaska (Wydoski and Whitney 1979). Unlike the coastrange sculpin, the prickly sculpin resides in the calm waters of rivers and streams (Wydoski and Whitney 1979). The prickly sculpin exhibits similar spawning strategies as the coastrange sculpin, becoming mature during their second, third, or fourth year and spawning in California during March and April (Figure 1). Fry hatch at lengths of 0.2 to 0.3 in. and soon start to swim (Moyle 1976). The juveniles are swept downstream to reside in pools and estuaries for three to five weeks. At 0.8 to 1.2 in. in length, juvenile prickly sculpins begin an upstream movement. Young feed on plankton and aquatic invertebrates, while larger fish target crustaceans, large benthic macroinvertebrates, and occasionally fish eggs and smaller fishes (Wydoski and Whitney 1979).

8. Sacramento Sucker (Catostomus occidentalis humboldtianus)

This sucker species is found throughout northern California in a variety of habitats, ranging from clear cold streams to sloughs (Moyle 1976; McGinnis 1984). Adult suckers tend to be found in aggregations, commonly at the head of a pool in stream habitats during the day and riffles at night (Moyle 1976). These long-lived, slow growing suckers spawn at age 4 or 5 (Moyle 1976). Like other sucker species, spawning takes place in the spring over gravels between February and June (Figure 1) (Moyle 1976). Sucker “runs” to upstream riffles are a common event in many rives and streams. Males are the first to arrive at the spawning grounds. Females deposit their adhesive eggs over the gravel substrate which are then fertilized by as many as eight or more males (Moyle 1976). Fecundity varies according to size, ranging from 2,415 to 35,556 (Moyle 1976). Newly emerged fry are displaced downstream by the current and feed on invertebrate drift (McGinnis 1984). Adults develop a fleshy inferior mouth and consequently tend to feed on algae, invertebrate larvae, and small crustaceans on the stream bottom (Moyle 1976).

9. Threespine Stickleback (*Gasterosteus aculeatus*)

One of the most widely distributed fishes in the world, the threespine stickleback exhibits a nearly circumpolar distribution, absent only from the Arctic Siberian coast (Sigler and Sigler 1987). In North America, the threespine stickleback is found on the west coast from Baja California to Washington. It inhabits quiet, cool (<73°F) backwaters near aquatic vegetation in fresh and marine waters (Moyle 1976). Most sticklebacks complete their life cycle within one year, spawning between April and July (Figures 1 and 2) (Moyle 1976). The male moves away from the school to set up breeding territories in the beds of aquatic plants. Here, he attracts a female to the nest which is composed of a shallow pit and algae or small plants (Sigler and Sigler 1987). The female is chased away after laying 50 to 300 eggs (Wydoski and Whitney 1979). The male incubates the nest, using his pectoral fins to move water over the eggs. After emerging from the nest, the juvenile threespine sticklebacks are guarded by the male until they are old enough to rejoin the school of sticklebacks (Moyle 1976). Threespine sticklebacks commonly feed upon zooplankton such as copepods and cladocerans and benthic aquatic invertebrates (Wydoski and Whitney 1979).

10. California Roach (*Lavinia symmetricus*)

The California roach is found in small, sometimes intermittent, tributaries in the Sacramento-San Joaquin system north to the Russian River in California (Moyle 1976). This species is able to withstand harsh conditions, like high water temperatures and low dissolved oxygen (DO), that may kill other fishes (McGinnis 1984). The California roach matures at age-2. Spawning takes place in July in the Russian River when the fish move from pools into riffle areas covered by small rocks. The California roach spawn in schools, beginning when the female deposits her eggs between the crevices of rocks where they are fertilized by several attending males (Moyle 1976). The adhesive eggs stick to rocks and hatch in two to three days. Juvenile fish remain in the rocks until they are large enough to swim around. Food consists of benthic items, predominately filamentous algae, aquatic macroinvertebrates, and crustaceans (Moyle 1976; McGinnis 1984).

11. Sacramento Squawfish (*Ptychocheilus grandis*)

The Sacramento squawfish is most prevalent in larger streams in the Sierra Nevada foothills where it is usually the top predator (Moyle 1976; McGinnis 1984). This species is common in the Sacramento-San Joaquin drainage, Monterey Bay, and the Russian River where it spends the majority of its time in deep, well-shaded pools (Moyle 1976; McGinnis 1984). The Sacramento squawfish matures at age-3 or -4 and spawns in the spring following an upstream migration to riffle areas in the stream (Figures 1 and 2)(Moyle 1976). Females are pursued by numerous males until they drop their eggs which are “simultaneously fertilized” (Moyle 1976). The eggs sink and stick to rocks where they hatch in approximately seven days. Juvenile Sacramento squawfish are found in schools until they mature and occupy positions in the stream conducive to their predatory behavior.

12. Eulachon (*Thaleichthys pacificus*)

A member of the smelt (Osmeridae) family, the eulachon is found on the west coast from the Klamath River, California north to the Bering Sea (Wydoski and Whitney 1979). The eulachon, the only truly anadromous species of freshwater smelt, inhabits Redwood Creek and the Mad River for portions of the year (Moyle 1976; McGinnis 1984). Also known as candlefish, eulachon spend most of their time in the Pacific Ocean, migrating to freshwater to spawn in the spring (Figure 2) (Moyle 1976). Inland migration in northern California usually begins in March and continues through April (Moyle 1976). The males arrive at the spawning grounds before the females, rarely venturing inland more than 6 to 7.5 miles (Moyle 1976). No nest is constructed; spawning takes place over gravel and sand substrates, and the average female deposits approximately 25,000 eggs (Moyle 1976; Wydoski and Whitney 1979). While eulachon are iteroparous, they rarely spawn more than one time (Moyle 1976). Shortly after emerging from the gravels juvenile eulachon are displaced to the sea, where little is known about their movements (Moyle 1976). Eulachon juveniles and adults are planktivorous, feeding on copepods, cladocerans, and worm larvae (Emmett et al. 1991).

13. Longfin Smelt (*Spirinchus thaleichthys*)

Longfin smelt range from Monterey Bay, California to Alaska (Emmett et al. 1991). The longfin smelt is classified as a euryhaline species because of its ability to tolerate various levels of salinity (Moyle 1976). In California, the longfin smelt inhabits most of the bays and estuaries north of San Francisco throughout the summer, moving into the lower reaches of rivers in the fall (Figure 2) (McGinnis 1984). Spawning takes place in the winter, each female laying between 5,000 and 24,000 eggs during a period from December through February (Figure 1) (Moyle 1976). Like the eulachon, longfin smelt are iteroparous, however, few individuals spawn more than once (Wydoski and Whitney 1979). The pelagic larvae move downstream quickly to an estuary where they reside until maturation (Emmett et al. 1991). Two-year-old longfin smelt display diel migrations utilizing deeper waters during the day and moving upward in the water column at night (Wydoski and Whitney 1979). All longfin smelt are zooplanktivorous (Emmett et al. 1991).

14. Tidewater Goby (Eucyclogobius newberryi)

The tidewater goby inhabits the estuaries and lagoons of small coastal streams from San Diego to Humboldt County (Moyle 1976; McGinnis 1984). The limited information available on the life history of this species indicates that it prefers the upper ends of lagoons which are at least partially separated from the ocean by sandbars (Moyle 1976; McGinnis 1984). The tidewater goby spawns over sand substrate (Moyle 1976).

Despite the limited life history information for the tidewater goby, this species has been recognized under the ESA. The tidewater goby has been listed as an endangered species under the ESA (61 FR 41515, 9 August 1996) and by the state of California.

15. Green Sturgeon (*Acipenser medirostris*)

Green sturgeon are found in the lower reaches of rivers north of the Sacramento-San Joaquin including the Mad and Eel rivers (Moyle 1976). Although most often found in marine waters, the green sturgeon has been found as far as 140 miles inland in the Columbia River (Wydoski and Whitney 1979). Smaller than the white sturgeon (*Acipenser transmontanus*), the green sturgeon can reach a length of 7 ft and weigh up to 350 pounds (Wydoski and Whitney 1979). Green sturgeon are iteroparous and are broadcast spawners. Little information exists on spawning substrates, but they are thought to follow the white sturgeon spawning pattern of spreading their eggs over clean sand in water with relatively swift velocities (Emmett et al. 1991). Benthic invertebrates, small fish, amphipods, and shrimp (Neomysis) compose the majority of the food taken by this bottom dwelling species (Moyle 1976; Wydoski and Whitney 1979; Emmett et al. 1991).

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